<u>OFFICE OF INDUSTRIAL TECHNOLOGIES</u>
<u>INDUSTRIES OF THE FUTURE</u>
<u>Chemicals Laboratory Call</u>

Guide for the preparation of
Research and Development Proposals
By DOE National Laboratories

A. INTRODUCTION

The U.S. Department of Energy (DOE), through the Office of Industrial Technologies (OIT), supports industry in its effort to increase energy efficiency, reduce waste, and increase productivity. The goal of OIT is to accelerate the development and use of advanced technologies that achieve energy efficiency and pollution prevention. These technologies benefit industry, the environment, and the nation's economy.

Through OIT's Industries of the Future strategy, the chemical industry developed a cooperative alliance with OIT. In 1996, the industry completed a vision for the industry's future entitled *Technology Vision 2020: The U.S. Chemical Industry.* The vision focuses on New Chemical Science and Engineering Technologies, Supply Chain Management, Information systems, and Manufacturing and Operations. Using the vision as guidance, the industry initiated workshops for the development of technology roadmaps that defined industry's research and development needs. These workshops and roadmaps, in the areas of catalysis; separations; computational fluid dynamics and chemistry; materials; reaction engineering; and alternative media, conditions and raw materials, outline key technology improvements necessary to increase energy efficiency in the chemical industry.

Approximately $2M per year is currently planned to be available to fund the Laboratory call. DOE envisions making four to eight awards each with a duration of three years or less for technology transfer to industry. At the same time, the current funding guarantee is only for one year and is subject to yearly appropriations. DOE also anticipates future commercialization by industry within five (5) years, including the planned maximum of three years of research. Applications which do not propose a teaming arrangement of at least two chemical industry companies(see section D.), will <u>not</u> be evaluated. **Teams will be required to develop an agreement either through a Cooperative Research and Development Agreement (CRADA) or an alternative agreement mechanism.** In either case, the teaming agreement must be approved by DOE and executed by all parties prior to allocation of funds.

B. TOPICAL AREAS

OIT seeks to support projects in those areas that offer significant opportunities toward reaching industry's goals and that relate to achieving energy efficiency and environmental improvements. The roadmaps and workshop reports identify potential areas likely to produce significant increases in energy efficiency, waste reduction, and productivity. Accordingly, OIT seeks proposals for projects in the following areas:

Alkanes and C1 Compounds as Feedstocks
There is considerable interest in the greater use of alkanes (methane, ethane, propane) and C1 compounds (carbon dioxide, carbon monoxide, formic acid, methane) as feedstocks in

the production of chemicals in place of olefins (ethylene, propylene). Olefins are petrochemicals derived in relatively energy-intensive processes and dominate as building blocks for major commodity chemicals and polymers. Methane is a naturally occurring substance (natural gas), and is not made commercially by a chemical reaction. C1 compounds are often produced as byproducts or industrial emissions, and could potentially be recovered for use as an inexpensive source of feedstocks. Efficient conversion of alkanes and C1 compounds to higher molecular weight chemical products could yield significant energy savings in processing energy as well as petroleum feedstock. To advance the use of alkanes and C1 compounds as feedstocks, new catalysts and synthetic pathways are needed. Note that oxidation processes, which are an important component of alkane and C1 synthesis, are covered under **Selective Oxidation**. The use of biological processes for conversion of alkanes and C1 compounds is covered under **Biocatalysis**. *Technology Vision 2020: The U.S. Chemical Industry* cites new chemistry using alternative raw materials, including carbon dioxide, as a priority need area. This topic area is also cited as a priority research area in three technology roadmaps and reports: Catalysis, Alternative Media, Conditions and Raw Materials, and Materials Technology. Selected examples of R&D include:

- Novel pathways for selective conversion of methane to higher valued products (platform chemicals)
- Stability and activation of the methane molecule
- Catalysts for selective synthesis of chemicals from CO and CO_2
- Chemical synthesis from C1 molecules
- Catalysts that form C-C, C-N bonds with CO_2
- CO_2 activation catalysts
- C1 chemistry, applied to the production of polymer building blocks (monomers)

Selective Oxidation

Oxidation (or dehydrogenation of an organic compound) is very important in the production of commodity chemicals and polymers. Examples include ethylene and propylene oxide (used to make glycols, polyester, and ethers), styrene, phenol and acetone, nitric acid, and many others. Improved oxidation processes, such as those that are more selective or proceed at lower temperatures, can reduce energy consumption by reducing heat requirements or decreasing the amount of reactions or steps necessary to make the desired compound. While not explicitly called out in *Technology Vision 2020: The U.S. Chemical Industry*, selective oxidation is covered in general under chemical synthesis and development of new catalysts and reaction systems. Selective oxidation is cited as a priority research area in two technology roadmaps and reports: Catalysis and Alternative Media, Conditions and Raw Materials. While not specifically called out in the Separations Roadmap, selective oxidation would greatly affect separation processes by reducing the amount of co-products. Selected examples of R&D include:

- Factors controlling selectivity in selective oxidation and oxidative dehydrogenation of alkanes
- Novel methods for activating oxygen
- Novel catalysts for the selective oxidation of alkanes, olefins, and aromatics
- Key oxidation/reduction chemistries to improve yield and selectivity
- Selective oxidation of organic matter using oxygen

Biocatalysis
Biocatalysis refers to the use of biological agents (enzymes) to catalyze reactions for the production of chemicals and chemical intermediates. Biocatalysts typically perform at ambient or near-ambient operating conditions (room temperature and pressure), while most chemical reactions catalyzed by heterogeneous catalysts require high temperatures and/or pressures. Using biocatalysts at ambient conditions could significantly reduce the large amounts of energy currently required to supply heat to conventional chemical processes. Research includes the study of new biocatalysts, biocatalyst chemistry, and processing methods for using biocatalysts (reactors, catalyst supports, separation of products, operating environments). **This solicitation is restricted to the use of non-carbohydrate sources, i.e., fossil-based feedstocks (petrochemicals, natural gas), including C1 compounds derived from these sources**. 'Bioprocessing and Biotechnology' is one of 6 areas targeted by *Technology Vision 2020: The U.S. Chemical Industry* under New Chemical Science and Engineering, with a focus on improved biocatalysts and biochemical processing. Biocatalysis is listed as a high impact area in two roadmaps and reports (Materials Technology and Alternative Media, Conditions and Raw Materials) and is the sole focus of a technology roadmap that is currently in progress. Selected examples of R&D include:

- Isolation of new enzymes
- Biocatalysts with enhanced specificity and activity
- Engineered enzymatic pathways
- Bioprocesses to produce monomers for polymer production
- Improved bioreactors

Membrane Separations
Separation processes are a costly, energy-intensive, but critical component of chemical processing. Membranes can be used to perform a variety of separations (liquid/gas, liquid/liquid, gas/liquid, gas/gas, solid/gas, etc.) and can be more efficient than conventional separations. Many are effected as the result of partial pressure and do not require an energy-intensive phase change (e.g., boiling a liquid to produce a gas). They require no moving parts, and can be carried out at ambient temperatures (no process heat required). Conventional separations are often much more inefficient. Distillation, for example, can use as much as 50% more energy than is thermodynamically required. It has been estimated that widespread adoption of membrane technologies could reduce annual energy consumption by almost 1.5 quads, mainly through applications in chemicals, petroleum refining, and food processing. Membranes are used mostly for bulk separations in chemicals manufacture, as they are most efficient for low purity applications. For higher purity, current membrane materials are often limited by flow restrictions, the tendency for fouling, material stability, and economics when compared with distillation. To advance the use of membrane separations, research is needed to develop new, more effective membrane materials and innovative ways to incorporate membranes in chemical processing. Improved membranes for chemical processing and other applications are cited as a research need in *Technology Vision 2020: The U.S. Chemical Industry* under Materials Technology; hybrid membrane systems are cited under Process Science & Engineering. An entire chapter is devoted to membranes in the *Vision 2020: Separations Roadmap 1998*, and they are mentioned in the upcoming *Vision 2020: Separations Roadmap 2000.* Improved membranes are also listed as high priority R&D topics in three other roadmaps and reports (Materials of Construction, Alternative Media, Conditions, and Raw Materials, Materials Technology). Selected examples of R&D include:

- Membrane reactors
- Membrane separations for high tonnage chemicals
- Low cost, very efficient membranes for separations
- Highly selective membranes for processes using alternative feedstocks
- Membranes for separating products from waste
- High temperature proton exchange membranes
- Materials for more selective separations

Selective Extraction

Selective extraction refers to liquid-liquid extraction, in which components of a mixture are separated based on their different solubilities in a solvent. It may include supercritical extraction, as long as solids are not involved. The term 'selective' refers to the selectivity of the solvent (or extractant) for specific components in the mixture. Extraction technologies are used in few large scale separation systems, primarily because current solvents are inadequate. Extraction can often be used to separate mixtures with similar boiling points, where distillation cannot be used. Extraction is usually operated at ambient or near-ambient conditions (requires no process heat), and has few moving parts, thus requires much less energy than other separation processes (e.g., distillation). A drawback is that the solvent (extractant) must be recovered after the separation, and this is usually done using distillation, which is energy-intensive. Very selective extraction processes would increase extraction efficiency, minimize the use of solvent, and reduce energy requirements for solvent recovery. *Technology Vision 2020: The U.S. Chemical Industry* cites the development of hybrid reactor systems as a priority (e.g., reactive extraction), and an entire chapter is devoted to extraction in the *Vision 2020: Separations Roadmap*. It is also cited as a priority R&D topic in the Alternative Media, Conditions, and Raw Materials Workshop Report. Selected examples of R&D include:

- More effective separation processes for bioprocessing
- Reactive extraction
- Highly selective solvents
- Entirely new solvents (ionic liquids, supercritical and dense phase fluids)

Separative Reactors

Separative reactors are unique in that the chemical reaction and separation occur simultaneously (e.g., reactive distillation). In separative reactors, the reaction and separation can be completed in one unit operation rather than two, saving significant process energy. In some cases, such as reactive distillation, the heat of reaction can be used to drive the distillation in the column, reaping large energy savings. Separative reactors are viewed as unproven on a large scale, and have few applications, despite the potential savings in capital and energy costs. The *Vision 2020: Separations Roadmap* devotes individual chapters to distillation, adsorption, crystallization and separative reactors. *Technology Vision 2020: The U.S. Chemical Industry* cites hybrid reactor systems, such as reactive distillation, as a priority research need. Reactive separations are also cited as a priority research area in the Alternative Processes Report. Selected examples of R&D include:

- Integration of reactor and separation systems, such as reactive distillation, hybrid reactor systems
- Reactive separations for new raw materials (e.g., C1 compounds)

Computational Technologies

Computational technologies are an integral part of chemical research, development, design and manufacture. An important component is computational fluid dynamics (CFD) of reactive systems, which refers to modeling the behavior of flowing fluids in systems where chemical reactions are taking place, possibly with phase changes occurring (gas to liquid, sometimes solids), and coupling fluid, heat and mass transfer phenomenon. Computational chemistry involves development of computational tools that predict the characteristics and behavior of chemical systems, including computations at the quantum scale, atomistic scale, and mesoscale, as well as bridging between the scales. Combinatorial chemistry techniques look at a large number of chemical variants at a time, test them for desired properties, and then identify the most promising. The energy benefits of computational technologies come from optimization of system performance and the more effective design and testing of new chemical processes and materials.

Computational technologies are cited as a research area in *Technology Vision 2020: The U.S. chemical Industry*, with CFD noted as a priority. Entire roadmaps are devoted to CFD and Computational Chemistry. Integrating combinatorial techniques in simulation tools is cited in *Technology Vision 2020: The U.S. Chemical Industry* as a priority research area under Computational Technologies, and under Chemical Synthesis. Combinatorial techniques can be applied to many areas of research, and are cited as a high priority in three roadmaps and reports (Separations, Materials of Construction, and Alternative Media, Conditions and Raw Materials). Selected examples of R&D include:

- CFD for reactive flows
- Characterizing multiphase mesoscale features of chemical systems
- Dynamic CFD modeling for extractive systems
- Reactive 3-D modeling, coupling CFD with reaction kinetics
- Simulation of complex, multi-site, multi-product environments
- Scaling of time dimensions
- Modular, transferrable molecular potentials
- Modeling corrosion and high temperature oxidation
- Computational design of catalysts and new polymeric materials
- Models for dense phase conditions and complex fluids
- New chemical synthesis based on a variety of new combinatorial methods
- Simulation tools that integrate combinational optimization and deal with uncertainty in simulations
- Combinatorial chemistry applied to selection and development of new solvents
- Development of adsorbents using combinatorial methods
- Application of combinatorial techniques to development of new ceramics and metals
- Combinatorial techniques for discovery of new electrocatalysts and biocatalysts

Electrochemistry

Electrochemistry (electrolysis, electrohydrodimerization) is used to produce a number of important chemicals (chlorine, sodium hydroxide, and hexamethyldiamine - used to make nylon). Electrochemical systems could potentially have an overall lower energy consumption than traditional systems based on heterogeneous catalysts, which require large amounts of process heat. The use of electrochemical systems is not more widespread because little is known about how to control reactions at electrodes, and electrochemical surface phenomenon. Research is needed to explore new electrocatalysts, better electrode systems, and new electro-based processes. Electrochemistry is cited as a priority topic in three roadmaps (Separations, Materials of Construction, and Alternative Media, Conditions, and Raw Materials). Selected examples of R&D include:

- Alternative electrode configurations and geometry
- Interactions between electro-magnetic fields and interfaces (fluids/solids)
- Application of combinatorial techniques to electrocatalysts
- Transport and liquid diffusion control problems in electrochemical systems
- Ionic membranes in aqueous systems
- New materials for electrolytic cells
- Better catalysts for electrochemistry
- Entirely new processes based on electrochemistry

Solid Acid/Base Catalysis

Acid and base catalysts are important in many chemical reactions. Homogeneous acid catalysts are commonly used in alkylation, where small hydrocarbon molecules are joined to form larger molecules. The most common of these is the Friedel-Crafts alkylation process, where hydrofluoric acid or aluminum chloride (a Lewis acid) are commonly used. Better catalysts that operate under less severe conditions (lower temperatures and pressures) could have a significant energy impact. Acid and base catalysts in use are also very corrosive, increasing the costs and energy expended in maintenance and operations. New catalysts, including viable solid acid and base catalysts, are cited in *Technology Vision 2020: The U.S. Chemical Industry* as a critical need area. Alkylation is listed as a critical application area in the Catalysis report. Acid-catalyzed reactions are cited in the Alternative Media, Conditions, and Raw Materials Report. Selected examples of R&D include:

- Viable solid acid and base catalysts to replace the toxic/corrosive mineral acids and bases
- Solid-acid alkylation catalysts with sustained activity at low temperatures
- Factors controlling acid site density and strength in solid acid catalysts
- Improved yield and selectivity in base- and acid-catalyzed reactions

C. ANTICIPATED AWARDS AND ESTIMATED FUNDING

DOE envisions that the research projects, funded through this call for proposals, should come to a proper closure within three (3) years for technology transfer to industry. DOE also anticipates future commercialization by industry within five (5) years, including the planned maximum of three years of research.

Fiscal Year 2000 DOE funding is planned for the initial effort. DOE funding for subsequent years will depend on several factors, including:

- Progress and results of the first year research determined during annual program review
- Availability of funds
- DOE program requirements and policy factors
- Estimated need and adoption of the expected results by the U.S. chemical industry

DOE anticipates that approximately $2M per year will be available to fund the Laboratory call. Depending on the quality of the submissions, approximately 4-8 projects are will be selected initially for funding.

D. ELIGIBILITY

National Laboratories are required to propose teaming arrangements with a least two or more chemical companies. Applications that do not propose a teaming arrangement of at least two chemical industry companies will <u>not</u> be evaluated. Teams must consist of two or more industrial chemical companies.

An “industrial chemical company” is defined as a private (profit or non-profit) organization that manufactures chemicals and allied products or provides products or services to such manufacturers. In addition to chemical and allied products manufacturers, raw material suppliers, equipment and technology suppliers, architectural and engineering companies, software and consulting firms, trade and professional associations, and research institutes, that routinely conduct a minimum of 10% of their business within the chemical industry manufacturers, are within the scope of the definition.

Teams may also include, but are not limited to, industry, universities, trade association, DOE National Laboratories, and small businesses which facilitate technology transfer to the private sector, promote commercialization, and enhance U.S. competitiveness**.**

As a result of the awards, the National Laboratory applicants will be required to describe the teaming arrangements that will be used and clarify how intellectual property developed in the project will be handled among the teaming partners. DOE prefers the teaming arrangement through the formal collaboration mechanism of a Cooperative Research and Development Agreement (CRADA). An alternative agreement mechanism may be proposed for DOE approval. Teaming agreements must be in place before the work can be initiated. **A copy of the negotiated CRADA or agreement, including the joint work statement, must be sent to Mr. P. Michael Ferrigan at the above address for final DOE programmatic review prior to allocation of funds. Official DOE approval by the cognizant Contracting Officer is required before the offerors can enter into a particular CRADA with an industrial partner.**

E. EVALUATION PROCEDURES AND CRITERIA

Proposals from national (Federal) laboratories submitted to OIT as a result of this program announcement will undergo merit review by a Merit Review Committee (MRC) composed of both government and non-government members. The following guidelines for content and format are intended to facilitate an understanding of the requirements necessary for OIT to conduct a merit review of a proposal. Please follow the guidelines carefully, as deviation could be cause for declination of a proposal without merit review.

Proposals will be reviewed by the MRC and the work will be evaluated in accordance with the following criteria. The relative weighting of each technical criterion is as follows:

1. Research concept and plan	15%
2. Economic and environmental benefits	15%
3. Energy benefits	30%

4. Multi-partner industrial involvement	30%
5. Applicant/team capabilities and facilities	10%

Selections will be made in accordance with the following selection criteria and programmatic considerations. All applications will be evaluated and point-scored in accordance with the following criteria. The applications must fully respond to each criterion.

Criterion 1 (15 points): Research Concept and Plan - The technical potential of the proposal shall be evaluated considering: a) the responsiveness of the proposal to research priorities identified by the chemical industry and described in Section B. b) the clarity, completeness, and adequacy of the statement of objectives (including a review of supporting data obtained in laboratory and/or pilot scale work completed to date); c) the technical merit and feasibility of the proposed work (i.e., based on sound scientific/engineering principles and on an understanding of current state of the art in the chemical industry); and d) the adequacy and appropriateness of the schedule (sequence of project tasks, planned levels of data acquisition, sampling and analyses, principal milestones, decision points, and time for each task) and the planned assignment of responsibilities and level of effort to complete the research.

Criterion 2 (15 points): Economic and Environmental Benefits - Benefits shall be evaluated considering: a) the general applicability, timeliness, and economic viability of the proposed technology (i.e., probability of commercial application) and the potential for enhancing the economic competitiveness of the chemical industry; and b) potential for reducing the environmental impacts of the domestic chemical industry. The tables in Appendix A must be completed.

Criterion 3 (30 points): Energy Benefits - Benefits shall be evaluated considering the potential for the proposed technology to contribute to the reduction of the energy consumption of the domestic chemical industry. The three tables in Appendix must be completed.

Criterion 4 (30 points): Multi-Partner Industrial Involvement – Industrial involvement shall be evaluated considering: a) participation by the chemical industry and/or supplier industries in preparation of the application and in performing the research activities; and b) in identification of, and commitment to, a viable mechanism, plan, or path to transfer the technology to industry at the earliest practicable time.

Criterion 5 (10 points): Applicant/Team Capabilities and Facilities - Capabilities and facilities shall be evaluated considering: a) ability to assemble a multi-disciplined team with research experience and qualifications in the proposal subject area; b) knowledge of past advanced developments in the work proposed; c) the availability of equipment, laboratory and demonstration facilities, analytic support and other necessary resources for performing the work proposed; and d) project management methods.

F. PROGRAMMATIC SELECTION CONSIDERATIONS

In conjunction with the evaluation results and rankings of individual applications, the Government shall make selections for negotiations and planned awards from among the highest ranking applications, using the following programmatic considerations:

- Selection of applications that support a balanced portfolio of projects that represent a diversity of technologies and proposing entities, and the most effective and efficient use of Federal funds.

- Supporting complementary efforts or projects that, taken together, will best achieve the Office of Industrial Technologies' Vision and Mission that is found on the Internet at http://www.oit.doe.gov.

- Applications addressing research priorities that potentially benefit the broad cross-section of the chemical industry.

- Programmatic goals include the desire for research projects that are balanced with respect to sector, long-term vs. short-term market penetration horizons, and short-duration vs. long-duration projects.

Applicants must present sufficient evidence and information to ensure that each criterion is adequately addressed. The MRC will base its evaluations only on information contained in the application. It cannot be assumed that members of the MRC are acquainted with the applicant, with any key individuals, or with any experiments or research referenced.

G. PROPOSAL FORMAT AND CONTENTS

The full proposals shall consist of two (2) volumes. Volume I (Technical Proposal) is mainly intended for the MRC to perform its duties. Volume II (Field Work Proposal) is solely used for DOE procurement actions, and contains the majority of cost information.

The cost information will not be point scored or adjectivally rated, but will be evaluated to assess the Applicant's understanding of the work, to determine if the total estimated cost proposed by the Applicant is commensurate with the technical effort proposed, and to confirm that the cost sharing requirements of the Laboratory call have been met.

a. Volume I: Technical Proposal (Not to exceed 26 pages, excluding the executive summary as well as sections 3 ("budget and cost share"), 4 ("literature cited") and 5 ("biographical sketches")

In order to properly classify each proposal for evaluation, identify a reference to one of the following topical areas on the top right-hand corner of the first page:

- **Alkanes and C1 compounds as feedstocks**
- **Selective oxidation**
- **Biocatalysis**
- **Membrane separations**
- **Selective extraction**
- **Separative reactors**
- **Computational technologies**
- **Electrochemistry**
- **Solid acid/base catalysis**

More detailed descriptions of these topics are listed above in Section B of this program announcement.

The technical proposal should contain a detailed discussion of the proposed work for each of the technical evaluation criteria cited in Section E of this Laboratory call.

1. Executive Summary

An Executive Summary is requested for informational and administrative purposes only. Accordingly, it will not be evaluated or point scored and should not exceed three (3) pages in length.

Briefly describe the proposed project, the technology's benefits, and how it supports energy efficiency, waste reduction, and enhanced productivity appropriate to the chemical industry. Specifically, describe how this proposed project supports the needs identified in the selected topic areas found in Section B. List all the team members, describe their role in the project and any experience relevant to the project. Estimate the project's total cost, the cost for each phase, year(s), or budget period, and the non-federal cost share commitments. Please make sure that the financial commitment of each participant is clearly listed.

Discuss how the "fairness" and "U.S. competitiveness" requirements as used in the technology transfer clauses of the Laboratory's M&O/M&I contracts have been addressed and met in selecting the partner(s) and negotiating the CRADA.

2. Technical Approach

The following areas will be evaluated and point scored. This technical approach should not exceed twenty-six (26) pages in length, including the three completed tables specified in Appendix A of the lab call.

a. Research Concept and Plan

Provide a detailed description of the work to be performed, the proposed technical approach to achieve results and the goals and objectives of the project. Describe how the proposal addresses one or more of the research priorities identified in Section B. Identify the specific goals and objectives for the research activities, including a summary of existing research laboratory/pilot scale work performed to date. Justify and/or explain the technical merit and feasibility of the proposed work. Present a plan to implement the project, describing the sequence and schedule of tasks, major milestones, decision points, and, for each task, identification of personnel and responsibilities as well as the required person-hours.

b. Economic and Environmental Benefits

Provide a detailed discussion of the economic and environmental benefits to be realized from the research activities. Discuss the relevance and applicability of the research to the needs of the chemical industry.

Identify the timeliness and reasonableness of the technology development. Elaborate on the economic viability and feasibility for commercial application and implementation. Discuss the probability that the proposed technology will improve economic competitiveness for the commercial domestic chemical industry. Specify the reduction of environmental impacts to the chemical industry and/or suppliers.

c. Energy Benefits

Complete the three (3) tables on potential energy savings and waste reduction set forth in Appendix A. Provide assumptions, quantitative estimates and rationale to delineate how the stated research activity will save energy while not negatively impacting the environment.

d. Industrial Involvement

Discuss the amount of industrial involvement in the management and implementation of the research activities. Identify all the participants, be they a manufacturer, supplier, or participant from academia, and the role of each player in the planning and preparation of the technical proposal and the roles in the follow-on performance of the research activities. Provide a detailed discussion of the plans, commitment mechanism, and schedule to transfer the technology to the chemical industry marketplace.

e. Applicant/Team Capabilities and Facilities

Discuss the capabilities of both the prime applicant and the team members to perform the project. Provide one-page resumes of the key individuals that are proposed, including, but not limited to, the project manager, the principal investigator, and others as necessary. Specify the percentage of time that each individual will dedicate to the project. Document the knowledge that each key individual possesses related to past research developments in the project area. Specify the availability of the necessary equipment, laboratory facilities, analytical support and other necessary ancillary resources required to perform the work. Discuss, in some detail, the methods and techniques of project management that will be employed.

3. Budget and Cost Shares

Provide a statement of the estimated costs, including a description of the total costs, total cost and cost share by phase, and cost share by the partnering entity(ies). The format for documenting the cost share is flexible.

The industrial partner(s) are required to cost share a minimum of 50% of the total project costs to be incurred under the proposed project to be eligible for award under this lab call. It is the DOE's preference that the partner(s) minimum cost share requirement of 50% be met for each year, phase, or budget period, as appropriate, under the proposed project. However, the cost share contribution for one phase may be as low as 30%, **provided that the overall project cost**

<u>share of at least 50% is attained.</u> It is important to note that the National Laboratories cannot contribute to the partner's costs if the work is done under a CRADA as planned by this Laboratory call because the Laboratories are directly funded by DOE. The industrial partner(s) will be required to contribute sufficient funds to assure that the overall minimum 50% cost share of the total project cost will be achieved.

4. Literature Cited

List all references cited in the narrative of the "Technical Approach" section. Limit citations to current literature relevant to the proposed research. Information about each reference should be sufficient for it to be located by a reviewer of the proposal.

5. Biographical Sketches

Provide biographical sketches of relevant senior personnel, other than those cited in "Applicant/Team Capabilities and Facilities" section above. This information is required for laboratory personnel as well as those from the subcontracting institutions. The biographical sketch is limited to a maximum of two pages for each individual.

<u>Note that the materials submitted in response to the requirements of sections 3, 4, and 5 are in addition to the 26-page limit specified in Section 2 "Technical Approach."</u>

b. Quarterly and Annual Reports

The Principal Investigator (PI) will submit a quarterly reports to provide progress being made on each project electronically via email or with a written report. The PI will submit an annual progress report with a detailed breakdown of the cost sharing and present these results to the Office of Industrial Technologies during annual program reviews.

c. Field Work Proposal (FWP)

Submit a FWP, with budget information only. Include total project costs and costs by fiscal year for the life of the project. Attach documentation that shows the cost share of the industry participants, as prepared for section G.a.3 above.

H. SUBMITTAL PROCEDURES

a. Number of Copies to Submit

Submit an original and five (5) copies of the full proposal (Volume I & II).

b. Deadlines

Full proposals are due no later than 3:00 Central Daylight Time on May 1, 2000 at the address shown below.

I. SUBMISSION SITE, QUESTIONS AND ANSWERS

All applications, referencing this Laboratory call, should be sent to:

Mr. P. Michael Ferrigan
Chemicals Lab Call '00
U. S. Department of Energy
Chicago Operations Office
9800 South Cass Avenue, Building 201
Argonne, IL 60439-4899
Telephone: (630) 252-2570, Fax (630) 252-8649
E-mail: michael.ferrigan@ch.doe.gov

Applications will be accepted if submitted U.S. Postal Service, including Express Mail, commercial mail delivery service, or hand delivery, but will not be accepted by fax, electronic mail, or other means. **Applications received after the identified deadline will not be considered.**

Technical and Non-technical questions should be submitted in writing to the attention of Michael Ferrigan via email at the above email address no later than May 1, 2000. Answers will be sent out through his email address.

J. AWARDS SELECTION

After the completion of the merit review, the OIT Chemicals Team will announce the selections through the Laboratory Coordinating Council.

K. DEBRIEFING

If a written request for a debriefing is received by Mr. P. Michael Ferrigan within 10 days after the announcement of the final selections, a verbal debriefing will be provided with information pertinent to DOE's evaluation of the application. Neither the identity of reviewers nor their verbatim comments will be disclosed.

APPENDIX A

Please complete tables 1,2, and 3 based on either an "installed unit" or "unit of production." An installed unit might be a new reactor vessel or newly designed distillation column with energy usage expressed as units per year. A production unit might be used for a new catalyst material or a different process (new steps/new procedure) for making the chemical. In the latter case, energy usage would be measured by an annual production rate, such as barrels, tons, or kg per year.

Before proceeding, pick and justify your selection for units. You must use the same units for all three tables. If the quantity of output per year will be different for the Current and Proposed Technologies, then please normalize the output to the same output.

You must list each assumption that you have used to report the numbers in each table. Please include a brief description of your rationale for each.

ONE INSTALLED OR UNIT OF PRODUCTION=______________________________

Energy Savings: (Required Table 1)

Energy Source	(a) **Current Technology** (Energy Used per Installed or Production Unit Per Year)	(b) **Proposed Technology** (Energy Used per Installed or Production Unit Per Year)
Electricity (kWh)		
Natural Gas (cubic feet)		
Petroleum (barrels)		
Coal (short tons)		
Feedstock (Btu, please specify)		
Renewable (Btu, please specify)		
Waste (Btu, please specify)		

The first column is the type of energy. The second column (a) is the energy consumed with the current technology. The third column (b) is the energy consumed by the proposed technology.

Environmental Savings from Reduction in Non-Combustion Related Emissions: (Table 2)

Complete Table 2 (if applicable) using the installed or production unit used in Table 1. Provide assumptions for table values in the narrative section of your application.

Waste Generated	(a) **Current Technology** (tons/unit/year)	(b) **Proposed Technology** (tons/unit/year)
CO_2		
Other Greenhouse Gases (please specify)		
Carbon Monoxide		
SO_2		
NO_x		
Particulates		
VOCs		
Hydrocarbons		
Other Waste Emissions (please specify)		

The first column is the type of waste. The second column (a) is the amount of wastes generated with the current technology. The third column (b) is the amount of wastes generated by the proposed technology.

Commercialization Market: (Required Table 3):

Please complete this table using the selected installed or unit of production used in Tables 1-3. Provide assumptions for table values in the narrative section of your application.

	1999	2002	2005	2010	2015	2020
(a) Potential Market * (number of units)						
(b) Capturable Market ** (number of units)						

* **The Potential Market is that fraction of the entire market to which your technology is truly applicable.**

Remember to project the number of installed or production units by first considering limiting factors related to technology and market fit**.**

For instance, the proposed technology may not fit each type of process:
_Your technology may only fit a certain size range of equipment

_Your technology may only fit within a certain class of process equipment

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**** Capturable Market is that fraction of the Potential Market willing to accept your new technology.**

Remember that the rate at which industrial technologies capture the market depends on:
_ Technology characteristics (technology economics, new vs. retrofit)
_ Industry characteristics (industry growth, competition)
_ External (government regulation, trade restrictions)

Please project the number of installed or production units in the Capturable Market by first considering these limiting factors related to rates of market acceptance.